Historical Developments in the Field of AI Planning and Search

AI Planning is basically the combination of logic and search to facilitate a more efficient method of searching for solutions to problems or prove the existence of a solution. Applications range from robotics to scheduling (like the air cargo problems in the planning project). With search techniques alone, you can create a problem-solving agent that is able to find sequences of actions that resulting a goal state. In order to achieve this, though, you domain-specific heuristics to perform well. Using logic alone, you can create domain-independent heuristics based on the logical structure of the problem and use that to generate plans. This approach, though, because of its dependance on ground propositional inference, becomes untenable when there are many states and actions. AI planning combines both approaches to find a balanced approach of using domain-independent heuristics to efficiently find a solution.

One of the first critical challenges in the history of AI Planning is how to represent planning problems in such a way that computers can parse the problems and then effectively apply different search problems in pursuit of the solution. One of the first major planning system, STRIPS, which was used as the planning components of the software for the Shakey robot project at SRI[1], was extremely influential in how we represent planning problems. STRIPS represented the world in a set of "well-formed formulas (wff)", operators grouped into families called schemata, and a goal condition stated as a wff[2]. This structure went through many derivatives, but its influence can still be seen in the modern classical planning representation language, Problem Domain Description Language, PDDL.

Another key development in the area of AI Planning is that of order. The original approach to solving problems was to decompose the problem's goal into subgoals. The planner would then serially create subplans for each subgoal. The overall solution would simply be the stringing together of each subplan. Unfortunately, this approach failed for some some simple problems, like the Sussman anomaly[3], where it was shown that due to interleaving of actions this approach would fail, namely because the actions of a subsequent subgoal could undo a previous subgoal. One solution to the interleaving problem was partial-order planning in which the conflicts and interferences are captured in the representation of the problem and only specifies the order of actions when necessary. Partial-order planning dominated the field during the 1980s and 1990s[1].

In 1995, Avrim Blum and Merrick Furst published their GRAPHPLAN system, which was orders of magnitude faster than the partial-order planners of the day[1,4]. The introduced the concept of a planning graph, which "encodes the planning problem in such a way that many useful constraints inherent in the problem become explicitly available to reduce the amount of search needed"[4]. This approach is the inspiration for the planning graph used in the planning project.

This is an exciting subfield of Artificial Intelligence that, like many, are rapidly developing and will likely be a locus of innovation.

References

1. Russell, S. J., Norvig, P., & Canny, J. (2003). Artificial intelligence: A modern approach.
2. Fikes, R. E., and Nilsson, N.J. (1971). STRIPS: A new approach to the application of theorem proving to problem solving. AIJ, 2(3-4), 189-208.
3. Sussman, G. J. (1975). A Computer Model of Skill Acquisition. Elsevier/North-Holland.
4. Blum. A. L. and Furst, M. (1995) Fast planning through planning graph analysis. In IJCAI-95, pp. 1636-1642.